amino-6-chloropurine, hypoxanthine, inosine and xanthine; 7-deaza-8-aza derivatives of adenine, guanine, 2-aminopurine, 2,6-diaminopurine, 2-amino-6-chloropurine, hypoxanthine, inosine and xanthine; 1-deaza derivatives of 2-aminopurine, 2,6-diaminopurine, 2-amino-6-chloropurine, hypoxanthine, inosine and xanthine; 7-deaza derivatives of 2-aminopurine, 2,6-diaminopurine, 2-amino-6-chloropurine, hypoxanthine, inosine and xanthine; 3-deaza derivatives of 2-aminopurine, 2,6-diaminopurine, 2-amino-6-chloropurine, hypoxanthine, inosine and xanthine; 6-azacytosine; 5-fluorocytosine; 5-chlorocytosine; 5-iodocytosine; 5-bromocytosine; 5-methylcytosine; 5-bromovinyluracil; 5-fluorouracil; 5-chlorouracil; 5-iodouracil; 5-bromouracil; 5-trifluoromethyluracil; 5-methoxymethyluracil; 5-ethynyluracil; 5-propynyluracil and the like.

Preferably, B is a 9-purinyl residue selected from guanyl, 3-deazaguanyl, 1-deazaguanyl, 8-azaguanyl, 7-deazaguanyl, adenyl, 3-deazaadenyl, 1-deazaadenyl, 8-azaadenyl, 7-deazaadenyl, 2,6-diaminopurinyl, 2-aminopurinyl, 6-chloro-2-aminopurinyl and 6-thio-2-aminopurinyl, or a B is a 1-pyrimidinyl residue selected from cytosinyl, 5-halocytosinyl, and 5-(C_1-C_3-alkyl)cytosinyl.

The invention compounds, such as those of the formulas $(L^1)(RO)P(O)$-Z-B, are optionally esterified at the phosphorus atom by the group R defined above.

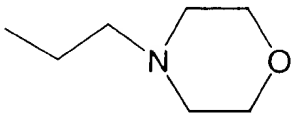
Exemplary R groups include X^1, X^2, X^3, R^5, NHR^{6A} and $N(R^{6A})$, wherein

X^1 is selected from the group consisting of 2- and 3-pyrrolyl, 2- and 3-thienyl, 2- and 4-imidazolyl, 2-, 4- and 5-oxazolyl, 3- and 4-isoxazolyl, 2-, 4- and 5-thiazolyl, 3-, 4- and 5-isothiazolyl, 3- and 4-pyrazolyl, 1-, 2-, 3- and 4-pyridinyl, and 2-, 4- and 5-pyrimidinyl;

X^2 is selected from the group consisting of phenyl, benzyl, $-C_6H_4CH_2-N(CH_3)_2$, 2-, 3- and 4-alkoxyphenyl (C_1-C_{12} alkyl including 2-, 3- and 4-methoxyphenyl and 2-, 3- and 4-ethoxyphenyl), 2-, 3- and 4-halophenyl (including 2-, 3- and 4-fluorophenyl), 2,3-, 2,4-, 2,5-, 2,6-, 3,4- and 3,5-dihalophenyl (including 2,4-difluorophenyl and 2,4-dichlorophenyl), 2-, 3- and 4-haloalkylphenyl (1 to 5 halogen

atoms, C_1-C_{12} alkyl including 2-, 3- and 4-trifluoromethylphenyl and 2-, 3-, and 4-trichloromethylphenyl), 2-, 3- and 4-cyanophenyl, carboalkoxyphenyl (C_1-C_4 alkyl including 2-, 3- and 4-carboethoxyphenyl (-C_6H_4-C(O)-OC_2H_5) and 2,3-, 2,4-, 2,5-, 2,6-, 3,4- and 3,5-dicarboethoxyphenyl), 2-, 3-, and 4-nitrophenyl, 2-, 3- and 4-haloalkylbenzyl (1 to 5 halogen atoms (C_1-C_{12} alkyl including 4-trifluoromethylbenzyl), alkylsalicylphenyl (C_1-C_4 alkyl including 2-, 3- and 4-ethylsalicylphenyl), 2-, 3- and 4-acetylphenyl, phenyl substituted by methoxy, ethoxy, OH, NH_2, halo, C_1-C_4 alkyl or C_1-C_4 alkyl substituted by OH or by 1 to 3 halo atoms, and -$C_{10}H_6OH$; and

X^3 is selected from the group consisting of alkoxy ethyl (C_1-C_6 alkyl including -CH_2-CH_2-O-CH_3),



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adamantoyloxymethyl, pivaloyloxy(methoxyethyl)methyl (-CH($CH_2CH_2OCH_3$)-O-C(O)-C(CH_3)3), 1-adamantane-carbonyloxymethyleneoxymethyl-, pivaloyloxymethyl (-CH_2-O-C(O)-C(CH_3)3), pivaloyloxy(methoxymethyl)-methyl (-CH(CH_2OCH_3)-O-C(O)-C(CH_3)3, pivaloyloxyisobutyl (-CH(CH(CH_3)2)-O-C(O)-C(CH_3)3), isobutyryloxymethyl (-CH_2-O-C(O)-CH_2-CH(CH_3)2), cyclohexanoyloxymethyl (-CH_2-O-C(O)-C_6H_{11}), isopropyl (-CH(CH_3)2), t-butyl (-C(CH_3)3), -CH_2-CH_3, -(CH_2)2-CH_3, -(CH_2)3-CH_3, -(CH_2)4-CH_3, -(CH_2)5-CH_3, -CH_2-CH_2F, -CH_2CH_2Cl, -CH_2-CF_3 and -CH_2-CCl_3;

or two R groups are joined to form substituents selected from the group consisting of -$C_{10}H_6$- and -$C_6H_4C_6H_4$-,

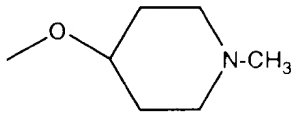
wherein R^5 is selected from the group consisting of $CH_2C(O)N(R^{6A})_2$, $CH_2C(O)OR^{6A}$, $CH_2OC(O)R^{6A}$, $CH(R^{6A})OC(O)R^{6A}$, $CH_2C(R^{6A})_2CH_2OH$, CH_2OR^{6A}, NH-CH_2-C(O)O-CH_2CH_3, N(CH_3)-CH_2-C(O)O-CH_2CH_3, NHR^{40},

CH_2-O-C(O)-C_6H_5, CH_2-O-C(O)-$C_{10}H_{15}$, -CH_2-O-C(O)-CH_2CH_3, CH_2-O-C(O)-$CH(CH_3)_2$, CH_2-O-C(O)-$C(CH_3)_3$, and CH_2-O-C(O)-CH_2-C_6H_5;

wherein R^{6A} is selected from the group consisting of C_1-C_{20} alkyl which is unsubstituted or substituted by substituents independently selected from the group consisting of OH, O, N and halogen (1 to 5 halogen atoms), C_6-C_{20} aryl which is unsubstituted or substituted by substituents independently selected from the group consisting of OH, O, N and halogen (1 to 5 halogen atoms) or C_7-C_{20} aryl-alkyl which is unsubstituted or substituted by substituents independently selected from the group consisting of OH, O, N and halogen (1 to 5 halogen atoms), wherein O and N are substituted for carbon and provided that the total number of R^5 or R carbon atoms is less than 25 (preferably about 4 - about 14) for compounds where R^5 or R is selected from the group consisting of $N(R^{6A})_2$, $CH_2C(O)N(R^{6A})_2$, $CH_2C(O)OR^{6A}$, $CH_2OC(O)R^{6A}$, $CH(R^{6A})OC(O)R^{6A}$ and $CH_2C(R^{6A})_2CH_2OH$; and

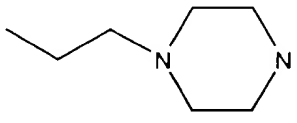
wherein R^{40} is C_1-C_{20} alkyl.

The invention compounds are optionally alkylated at the α-nitrogen atom of the amino acid by the R^1 group defined above. Exemplary R^1 groups include H, CH_3, CH_2CH_3, benzyl, 4-O-N-methylpiperidinyl

( ; -O-CH[$(CH_2)_2(CH_2)_2$]N(CH_3)), 3-O-N-methylpiperidinyl and the like.

The invention compounds are optionally esterified at the amino acid carboxyl moiety by the R^4 group defined above. Exemplary R^4 groups include H, methyl, ethyl, propyl, isopropyl, butyl, t-butyl ($C(CH_3)_3$), phenyl (-C_6H_5), benzyl (-CH_2-C_6H_5), 1-pyridyl, 3-pyridyl, 1-pyrimidinyl, N-ethylmorpholino

(-CH_2-CH_2-N[$(CH_2)_2(CH_2)_2$]O), N-2-propylmorpholino (-$CH(CH_3)$-CH_2-N[$(CH_2)_2(CH_2)_2$]O), methoxyethyl (-CH_2-CH_2-O-CH_3), 4-N-methylpiperidyl (-CH[$(CH_2)_2(CH_2)_2$]$N(CH_3)$), 3-N-methylpiperidyl, phenol which is 2-, 3-, or 4-substituted by $N(R^{30})_2$ where R^{30} is independently H or C_1-C_6 alkyl unsubstituted or substituted by substituents independently selected from the group consisting of OH, O, N, $COOR^4$ and halogen or C_6-C_{12} aryl unsubstituted or substituted by substituents independently selected from the group consisting of OH, O, N, $COOR^4$, $N(R^7)_2$ and halogen (including 2-, 3-, and 4-N,N-dimethylaminophenol and 2-, 3-, and 4-N,N-diethylaminophenol), 1-ethylpiperazinyl

[

; -CH_2-CH_2-NC_4H_8NH], and N^4-substituted 1-ethyl-piperazinyl (-$(CH_2)_2$-N[$(CH_2)_2(CH_2)_2$]NR^2, where R^2 is as defined above).

Additional compounds that are included in the invention are nucleotide analog dimers that are linked via an amino or carboxyl group. As used herein, dimers (or trimers) refer to the presence of two (or three) nucleoside residues that comprise a compound. Thus, a -L^1-P(O)(L^1)-Z-B or -P(O)(L^1)-Z-B radical covalently linked to a -L^1-P(O)(L^1)-Z-B or -P(O)(L^1)-Z-B radical gives B-Z-P(O)(L^1)-P(O)(L^1)-Z-B, B-Z-P(O)(L^1)-L^1-P(O)(L^1)-Z-B or B-Z-P(O)(L^1)-L^1-L^1-P(O)(L^1)-Z-B.